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A DYNAMIC RESPONSE OF POTASSIUM AND MICRO NUTRIENTS COMBINED WITH BRASSINOSTEROIDS - A STEROIDAL PLANT HORMONE, ON ACCUMULATION OF SUGARS IN PAPAYA CV. TNAU PAPAYA CO8

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ABSTRACT

An investigation is conducted to study the effect of potassium, micronutrients viz., zinc, boron, and brassinosteroids, a plant growth hormone on accumulation of sugar content in papaya cultivar TNAU PAPAYA CO 8, at Tamil Nadu Agricultural University, Coimbatore. Potassium was applied in 2 different forms and in two different levels as alone and as well as combined along with micro nutrients (Zinc @ 0.5% and Boron @ 0.1%) and steroidal plant growth regulator viz., brassinosteroids (2ppm) at different stages i.e., flowering, at fruit set and at harvesting stage. The experiment was laid out in randomized block design. The results of the experiment revealed that the application of potassium sulphate 2% along with Zinc (0.5%), Boron (0.1%) and brassinosteroids 2ppm had a positive emphasis on the sugar content of papaya cv. TNAU PAPAYA CO8. The total soluble solids, total sugars and sugar acid ratio were significantly influenced in the plants sprayed with potassium sulphate 2% + Zn (0.5%) + B (0.1%) + Brassinosteroids (2ppm).

KEYWORDS: Papaya, Potassium, Micronutrients, Brassinosteroids, Sugars

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Original Article

INTRODUCTION

Papaya (*Carica papaya*), the commercially important fruit crop belonging to the Caricaceae family is more a protective fruit due to its abundant source of carbohydrates, minerals, vitamins, ascorbic acid available in the fruit. It is well adapted to tropical and subtropical envionments. Fruit growth is associated with common phenomenon of accumulation of sugars due to starch degradation, further leading to maturation and ripening. Various nutrients and plant growth regulators play a crucial role, which is inevitable in the process of sugar accumulation and fruit growth. Among macro nutrients, potassium regulates photosynthesis and it is also essential for starch synthesis and sugar accumulation by activating enzymes *viz.*, starch synthetase, *etc*., (Lester *et al.*, 2010). Potassium is excessively required during fruit maturation stage for enhancing the fruit size, colour and taste of fruits (Ganeshamurthy *et al.*, 2011). Among micro nutrients *viz.*, zinc and boron are essential for growth and development of papaya fruits, affecting various biological processes such as photosynthesis, synthesis of nucleic acids, proteins and carbohydrates (Marschner, 1995; Uchida, 2000; Bhatt *et al.*, 2012).

Brassinosteroids (BRs) are a class of polyhydroxy steroids that have been recognized as a sixth class of plant hormones first identified in 1979 from *Brassica napus* pollens (Bishop and Koncz, 2002). It regulates

diverse physiological processes in plants and enhances the yield and quality of produces (Fariduddin *et al*., 2014). In the present investigation, influence of potassium as foliar application along with micronutrients and brassinosteroids, a plant growth regulator is studied in the papaya cultivar CO8 with respect to sugar accumulation in fruit pulp.

MATERIALS AND METHODS

The study was carried out at orchard of Horticultural College and Research Institute, TNAU, Coimbatore in 2014. The 'TNAU PAPAYA CO 8', a dioecious red fleshed papaya cultivar, planted at a spacing of 1.8 m X 1.8 m in a 0.5 acre land area formed the materials of the study. The treatments were laid out in randomized block design with 12 treatments and 3 replications. The treatment details of the study are as follows: T1 - Foliar application of Zn SO4 (0.5%) + Borax (0.1%) (control); T2 - Foliar application of KH2PO4 (1%); T3 - Foliar application of SOP (2%) ; T4 - Foliar application of KH2PO4 or MKP (2%) ; T5 - Foliar application of Brassinosteroids (2ppm); T6 = Foliar application of Zn SO4 (0.5%) + Borax (0.1%) + KH2PO4 (1%); T7 = Foliar application of Zn SO4 (0.5%) + Borax (0.1%) + SOP (2%); T8 = Foliar application of Zn SO4 (0.5%) + Borax (0.1%) + KH_2PO_4 (2%); T_9 = Foliar application of Zn SO_4 (0.5%) + Borax (0.1%) + Brassinosteroids (2ppm); T_{10} = T1 + T2 + T5 ; T_{11} = T1 + T3 + T5; T_{12} = T1 + T4 + T5. All the treatments were sprayed for 3 times at flowering, at fruit set and one month after fruit set stage.

After harvesting, papaya fruits were assessed for quality attributes *viz.,* TSS, acidity, total sugars, reducing and non reducing sugars. The total soluble solids of fruits were measured using 'ERMA' hand refractrometer. Titrable acidity was determined as per the AOAC. The total sugars were estimated as per the method suggested by Somogyi (1952) and the sugar: acid ratio was calculated by dividing total sugar content with acidity.

RESULTS AND DISCUSSIONS

Total Soluble Solids and Total Sugars

The data indicated that the Total Soluble Solids (TSS) and total sugars content was significantly influenced by the foliar treatments of potassium, micro nutrients and brassinosteroids. The papaya plants which received the treatment combination of $ZnSO_4$ (0.5%) + Borax (0.1%) + SOP (2%) + Brassinosteroids (2ppm) (T_{11}) recorded highest TSS of 13.63 ^{o}Brix. It was followed by foliar application of $ZnSO_4$ (0.5%) + Borax (0.1%) + KH_2PO_4 (2%) + Brassinosteroids (2ppm) (T12) with TSS value of 12.80 ^{o}Brix as shown in Table 1. Generally, the increase in TSS is associated with more conversion of starch into reducing and non-reducing sugars during ripening process. It may be also resulted due to cell elongation accompanied with increase in sugar content (Syamal *et al.,* 2010). Similar results were obtained by Kaur and Dhillon (2006) in guava cv. Allahabad Safeda sprayed with 3% K_2SO_4 and by Singh *et al*. (2009) in phalsa sprayed with urea 2% + potassium sulphate 0.2% + copper sulphate 0.2% registered an increase in TSS of 10.04% and 28.55% respectively. Zinc (0.5%) and Boron (0.1%) also had a profound effect on elevating the TSS content and it is supported by the results obtained in papaya by Kavitha (2000) and Jeyakumar (2001) citing the involvement of Zinc and Boron in efficient translocation of photosynthates to fruit pulp and hydrolysis of complex polysaccharides into simple sugars. In 'Red Globe' grapes, bunch spray of GA_3 (20 ppm) + Brassinosteroid (2 ppm) at8-10 mm berry diameter stage, enhanced the quality with respect to increased TSS (16.74 ^{o}Brix and 17.42 ^{o}Brix) in both winter and summer season (Ravikumar, 2014).

Similarly treatment T_{11} (Zn SO_4 (0.5%) + Borax (0.1%) + SOP (2%) + Brassinosteroids (2ppm)) recorded the maximum per cent of total sugars (10.75%) followed by T_{12} (10.45%). The increased sugar accumulation is due to the

higher potassium content and micro nutrients. Potassium is important especially after the fertilization of the flowers to produce larger, better quality fruits, with elevated levels of sugars and total soluble solids (Kumar *et al.*, 2006). Moreover, the potassium content in K_2SO_4 was about 54% which is considerably high than other source of potassium used in the treatment. The results were in conformity with the works carried out by Singh *et al.* (2009) in phalsa and by Gill *et al.* (2012) in Patharnakh' pear recording a high total sugar content (22.24% and 7.84%) by foliar application of K_2SO_4. As micronutrients play a essential role in fruit growth and metabolism, the combination of potassium with micro nutrients like zinc and boron gave a significant result in case of sugar content of treated fruits. It is similar with results of Jeyakumar *et al.*, (2001) stated that zinc and boron helps in photosynthates assimilation and sugar transport. In 'Red Globe' grapes, bunch spray of GA_3 (20 ppm) + Brassinosteroid (2 ppm) at8-10 mm berry diameter stage, enhanced the quality with respect to increased total sugars (11.56% and 12.60%) in both winter and summer season (Ravikumar, 2014)

Acidity and Sugar Acid Ratio

The acidity and sugar acid ratio is a good indicator of quality of papaya fruits, as it relays on the amount of conversion of starches and acids into sugars. The treatments showed statistically significant effect on the acidity per cent and sugar acid ratio of papaya. A reduction in acidity (0.13%) was noted in papaya plants sprayed with the Zn SO_4 (0.5%) + Borax (0.1%) + SOP (2%) + Brassinosteroids (2ppm) followed by T_{12} (0.14%). In case of sugar acid ratio, the significant results were obtained with all treatments and T_{11} recorded the high sugar acid ratio (82.69), followed by T_{12} (74.64) as shown in Table 1. The results were similar to the work done by Kaur and Dhillon (2006) in guava cv. Allahabad Safeda and by Singh *et al.* (2009) in phalsa. Ravikumar (2014) reported that sugar acid ratio was increased than control when 'Red Globe' grapes was sprayed with GA_3 (20 ppm) + Brassinosteroid (2 ppm) at 8-10 mm berry diameter stage. Brassinosteroids enhances the final sugar levels in fruits by efficiently converting the acids into simple sugars (Symons *et al.*, 2006). Brassinosteroids also activates the synthesis of nucleic acid, proteins and effects on amino acid composition, enhances the photosynthetic capacity and photo assimilation leading to high yield with increased fruit size and nutritive quality (Khripach *et al.*, 2000). Thus foliar application of brassinosteroids along with potassium and micro nutrients shows a dynamic response in the sugar accumulation and enhances the quality of papaya fruits. It was in conformity with the results obtained by Ravikumar (2014) in 'Red Globe' grapes, the acidity was reduced to 0.37% and 0.27% and highest sugar acid ratio of 32.40 and 48.23 was registered in both winter and summer season by bunch spraying of GA_3 (20 ppm) + Brassinosteroid (2 ppm) at 8-10 mm berry diameter stage.

CONCLUSIONS

Based on the results obtained in the present investigation, a differential rate of sugar accumulation and acid content was observed due to the treatment effects of potassium, micro nutrients and brassinosteroids. Hence, it is evident that the foliar application of nutrients especially B, Zn, and K and brassinosteroids in combination, is beneficial for acceleration of fruit development with good quality. In case of low availability of nutrients in soil, B, Zn, and K are termed to be major yield limiting nutrients, so, foliar application of nutrients show a rapid response in correction of nutrient deficiencies in fruits, and enhances quality and shelf life.

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APPENDICES

Table 1: Effect of Potassium, Micronutrients and Brassinosteroids On Sugar Content of Papaya Cv. TNAU PAPAYA CO8

Treatments	TSS (^{O}brix)	Total Sugars (%)	Titrable Acidity (%)	Sugar Acid Ratio
T_1	10.75	8.27	0.18	45.94
T_2	10.90	8.68	0.15	57.87
T_3	11.93	9.50	0.13	73.08
T_4	11.16	8.77	0.14	62.64
T_5	10.93	8.56	0.19	45.05
T_6	11.15	8.83	0.14	63.07
T_7	12.01	9.27	0.13	71.31
T_8	11.40	8.80	0.14	62.86
T_9	11.10	8.40	0.17	49.41
T_{10}	11.52	8.92	0.15	59.47
T_{11}	13.63	10.75	0.13	82.69
T_{12}	12.80	10.45	0.14	74.64
MEAN	11.61	9.1	0.15	62.33
SEd	0.53	0.50	0.01	0.58
CD	1.11**	1.04**	0.02**	1.20**

**Significance at 1%.